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AUTHOR Heflich, David A.
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ABSTRACT

Constructivist teaching has become a dominant theme in educational literature in response to the positivist model of education that is prevalent in schools. In order for K-12 education to become more constructivist, there must be a qualitative change in teaching practice from didactic to self-directed student learning. The use of online technology as computer mediated communication encourages teachers to become more committed to individualized instruction and small group work, which are both elements of self-directed students. This study investigated the attitudes and practices of educators who are participants in online educational discussion groups. The sample consisted of 25 respondents representing 16 states and 6 countries, and elementary, secondary, and K-12 schools. Teachers from two different groups of schools were identified: those who work in an environment in which the use of online technology is thoroughly infused in all aspects of the curriculum; and those for whom there is little support for their use of online technology in their classroom. Online interviews were conducted to determine if those using online technology as an integral part of the school curriculum are more likely to exhibit the attitudes and behaviors of constructivist teachers than those who do not. The study found that (1) a high degree of access to online computer technology enhances constructivist teaching and learning, and (2) a positive school climate is needed for access to develop. The interview questions are included. (Contains 63 references.) (Author/SWC)

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THE IMPACT OF ONLINE TECHNOLOGY ON TEACHING AND LEARNING: ATTITUDES AND IDEAS OF EDUCATORS IN THE FIELD

by

DAVID A. HEFLICH

A paper presented at the Twenty-fifth annual meeting
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Area of Professional Studies
College of Education
The University of Alabama

Box 865158
Tuscaloosa, AL 35486
205-562-8556
dheflich@dbtech.net

IR 018 227

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Abstract

Constructivist teaching has become a dominant theme in educational literature in response to the positivist model of education that is prevalent in schools. It is generally acknowledged that in order for K-12 education to become more constructivist there must be a qualitative change in teaching practice from more didactic to self-directed student learning. Research on the use of online technology as computer mediated communication suggests that it encourages teachers to become more committed to individualized instruction, and small group work, which are both elements of self-directed student

This study investigated the attitudes and practices of educators who are participants in online educational discussion groups. Teachers from two different groups of schools were identified. Those who work in an environment in which the use of online technology is thoroughly infused in all aspects of the curriculum; and those for whom there is little support for their use of online technology in their classroom. Online interviews were conducted with them to determine if those using on-line technology as an integral part of the school curriculum are more likely to exhibit the attitudes and behaviors of constructivist teachers, than those who do not.

Introduction

Constructivist teaching has become a dominant theme in educational literature, in contrast to the objectivist educational tradition which is prevalent in schools. Constructivism is the belief that children construct meaning by integrating their experiences into their previously constructed knowledge of how the world is organized. A constructivist conception of learning assumes that children learn best when problems are presented to them in the context of authentic situations, in an open cooperative environment that can be called a learning community (Brown & Campione,1994). The social interactions in which they are involved in the classroom help students construct unique understandings that they integrate into their previously held views of the world. Thus, constructivist learning can be conceptualized as a movement from an objectivist view of the world in which knowledge is rigid and fixed to a constructivist in which knowledge is an individual creation.

In contrast to constructivism, objectivist thought assumes that reliable knowledge of the world exists, independent of an individual's ability to perceive it (Jonassen, 1992). The objective tradition assumes that the world itself is objective, and measurable. Aspects of the world can thus be structured and modeled in ways that learners can understand. Learners gain knowledge and develop understanding as information about reality is transmitted to them by teachers. The mind, according to objectivists, exists to reflect the objective reality of the world, by processing external meaning through its interactions with structured models of reality. Thus, objectivist education is conceived of as the assimilation of an objective reality (Jonassen, 1992).

The objectivist tradition is alive and well in schools. It is characterized by teachers who view themselves as the source of knowledge and understanding. They use didactic teaching methods to instruct a room full of students. The disciplinary content that they transmit is objective knowledge that is measurable. A students' knowledge of transmitted content can thus be measured by an objective test. This paradigm continues to dominate classroom practice. Teachers still emphasize the transmission of disciplinary content. Many classrooms continue to be organized with desks aligned, facing front, with all eyes on the expert teacher, delivering knowledge to learners.

Constructivism is difficult to practice in a traditional classroom. Recently, a number of authors have postulated that computer technology, particularly online computer technology used as computer mediated communication (CMC), supports a change from didactic to constructivist teaching practice. Wilson and his colleagues (1993, 1995) found a movement towards more constructivist practice while evaluating the changes in the teacher-learner relationship that occurred during the creation of a technology rich environment at a Colorado elementary school. Riel (1990, 1993) found that online communication

among classrooms of students tends to open avenues of collaborative communication among teachers that may have implications for the culture of teaching and learning. Indeed, online education has been discussed by some as having the potential to change the very nature of the student-teacher relationship by stimulating the individual construction of knowledge on the part of learners (Teles, 1993). Recognition of this phenomenon implies changing roles for teachers, and for learners.

Yet, many school systems, even those that use computers in the schools, are filled with educators who teach in a traditional, didactic manner. This is due to the very strong structural and sociocultural contexts in which teachers work (Cornbleth, 1990). The culture of schooling is built upon teacher practice and on teacher, administrator, and community beliefs about curriculum, content and learning. It has been historically resistant to the many educational innovations that have been introduced over the years. Therefore many educators are likely to view the constructivist educational movement, and the use of online computer technology, as fads whose time will pass, just as other innovations have come and gone. (Cuban, 1986, 1993).

This study is concerned with understanding if online technology is another educational fad, or if it truly contributes to the changes in educational practice from didactic to constructivist methodologies. It focuses on the attitudes and practices of educators who have access to online computer technology and are members of online educational discussion groups. Some of these work in schools with technology rich environments in which the use of online technology is thoroughly infused throughout the curriculum. Others, are in schools where they work in isolation and are the only users of online computer technology in the classroom, and/or they are attempting to use it without the support of others in the school. This discussion asks if teachers who use online technology throughout the curriculum exhibit more of the tendencies towards a practice based upon the ideals of a constructivist educational movement than those whose use of online technology is limited by the structural and socio-cultural contexts in which they work. It further investigates the contextual factors that limit the full integration of online computer technology into the curriculum of those schools in which it is now used in a merely supplemental manner.

Given the overwhelming growth of computer use in society, and the rapid growth of online communications in this decade, the answers to these questions will help us understand the potential impact of online computer technology on education. Furthermore, given the growing belief in constructivist thinking, an understanding of the role technology plays in supporting changing classroom practice may help us re-conceptualize teaching and learning.

CONCEPTUAL FRAMEWORK

Constructivism is the general belief that individuals learn by constructing their own idiosyncratic meanings of reality as they interact with the environment. Learning is the goal of constructivism, rather than knowing. Conceptions of constructivist thought have developed from at least two distinct traditions in developmental psychology: the Vygotskian belief that children construct knowledge during their indoctrination into the community at large; and the Piagetian perspective that individuals construct knowledge on their own as they interact with the environment. Although psychologically distinct, the two traditions share the belief that learning is predicated on individual students' active involvement with their surroundings (Schifter & Simon, 1992). Vygotskian socioculturalists place more emphasis on the importance of the teacher and the social milieu of the classroom, since knowledge is defined as a cultural entity; and the Piatgetians place a stronger emphasis on the biological aspects of the individual learner (Richardson, 1994). Constructivist thinking may also be traced to experimental psychology (Bartlett, 1932; Iran-Nejad, 1980). Educational practices that spring from these differing conceptions of constructivism are remarkably similar. Both theories emphasize that students should be actively engaged in their learning, in activities which are situated in a context that is authentic in so far as it is rooted in the students' own, real world experience (Cobb, 1994).

A number of researchers point to constructivism as an alternative to the dominant didactic methodologies found in schools (Richardson, 1994), which rely on an objective view of the world in which

learning is conceptualized as the transmission of factual knowledge by those who are cognizant of it, to those who are not. Didactic models are based upon teacher authority in the control of both student activity in the classroom and the knowledge they will learn. A didactic teacher is typically located in the front of the room lecturing to the whole class. Students are sitting quietly in rows. They are all being taught the same thing at the same time. Because it is objective knowledge, teachers in didactic classrooms evaluate student learning through a written, objective test. Students roles in a didactic conception of learning are of those passive receptacles waiting to be filled with knowledge (Friere, 1971).

Any movement from didactic to constructivist learning will involve a change in teacher beliefs and practices (Sarason, 1991). Constructivist teachers conceptualize learning as something one does while interacting with the environment. This assumes students will be moving about the classroom. Whole class instruction is minimized. Constructivism changes the role of the teacher from an authority about what is being learned to a coach who seeks to facilitate student learning. The social structure of the classroom changes from a rigidly controlled environment with power situated in the teacher to a more supportive environment where power to direct their own learning is given to the students.

Constructivism as used here represents a change in beliefs about knowledge, teacher practice and classroom culture that can best be characterized as an educational movement encompassing a number of current educational trends (Marsh & Iran-Nejad, 1994). Collins (1991), for example, identified eight specific changes in teaching practice and classroom culture that he suggests represent a movement from didactic teaching to instruction based upon constructivist beliefs. Together, they represent an attempt to portray aspects of life in a classroom along a continuum of practice that represent the extremes of didactic and constructivist teaching (see table 1).

Online Technology in Education

Great claims have been made on behalf of the benefits of Compter Mediated Communication (CMC) for teaching and learning. Teachers and students at the Peakview Elementary School experienced changes in their teacher-learner dynamic that can be characterized as more constructivist than didactic (Wilson, et al., 1993). Specifically these represent adaptations to the eight trends in teacher behavior that Collins (1991) has characterized as constructivist (See Table 1). Wilson et al. report strongly positive effects for the use of technology in the classroom and its impact on teaching methods, teacher attitudes, student achievement and student attitudes (Wilson, et al., 1993).

Riel (1990, 1993, 1994) describes the impact of her work with learning circles in K-12 school settings. Learning circles, groups of 6-10 classrooms working together as a cooperative group to undertake joint projects, are facilitated by CMC. The structure of learning circle projects puts teachers and students together as researchers working on a project. Their partners are classrooms, separated physically and temporally, which are nonetheless interactive groups engaged in communication with each other. Learning circles offer opportunities for authentic learning through the interaction of students in different locations, possessing different cultural frames of reference. Students participating in learning circles dedicated to student writing have demonstrated significant gains in writing ability using various assessment techniques (Riel, 1993). Learning circles also offer opportunities for the professional growth that emerges from teacher collaboration (Riel, 1990).

These findings are supported by the work of the Apple Classroom of Tomorrow (ACOT). Begun in 1986, ACOT examines the changes taking place in technology rich classrooms. Participating teachers typically experience a personal conflict between their beliefs about control and structure in the classroom and the active learning engendered by the use and presence of technology (Dwyer, et al, 1990b). Dwyer et al (1990a) cite a five step process of change for teachers who are making the transition from traditional to technology rich environments. The first is the point of entry, when new technology enters the classroom. Adoption is when teachers and students first begin to use the new technology, typically in a fashion that fits in with their existing paradigm of education. Use of computers as drill and practice machines is the norm during the adoption phase. As computer use increases teachers adapt to it in the third phase of the change

process. Adaptation is stimulated by a realization of the productivity that computers allowed. Students are more engaged, learning more, faster, and with greater understanding than previously (Dwyer, et al, 1990a). Appropriation occurs when teachers themselves master the computer; when it becomes a tool for doing actual work. Recognizing the developmental aspects of change and the power that teachers gain from appropriating technology, Dwyer et al (1990a) propose another phase, invention, to mark where teachers are going with technology.

The promise of online technology is one of the major topics discussed in the Office of Technology Assessment (1995) report. Although very little hard data exists about the impact of technology on teachers, it is clearly apparent that those with more technological experience quickly learn new ways of using technology in ways that make their work more efficient. The OTA study (1995) distinguishes between teacher-centered instruction, or didactic teaching, and student-centered instruction. Teacher-centered instructors tend to use computer technology in a didactic manner, emphasizing its use to reinforce skills with drill and practice software. Student-centered instructors use computer technology in a more collaborative fashion. Furthermore, they are more enthusiastic about its use because it supports their style of teaching (U.S. Congress, Office of Technology Assessment, 1995).

The changing role of teachers that emerges from the use of CMC is reiterated in the literature. Teacher education and on-going professional development opportunities are now being offered online (Schrum, 1992). The use of online computer conferencing has been used to affect the moral development of preservice teachers by providing them with a venue for reflective discussion (Harrington, 1992). Perhaps the most significant impact that online technology has for teachers is the increased communication it offers. It can expand teachers' boundaries, allowing them contact with colleagues, school offices, experts in various fields, and parents (U.S. Congress, Office of Technology Assessment, 1995). The multiplicity of sources of information available online affects teachers as learners (Gunawardena, 1992). Direct connections that teachers can make through the use of CMC can help overcome the barriers to professional growth that are the byproducts of teaching in isolation (Riel, 1993). Teachers who are members of TENET, The Texas Educational Network, stress their own professional development, but also speak of the immediacy that access to online resources brings to their daily practice. These teachers also attribute increased student performance to their exposure to CMC (David, 1993). Teachers who use online technology in the classroom change their behavior in ways that can best be described as more constructivist (Fowler & Wheeler, 1995).

The Current State of Online Technology in Schools: Barriers to Change tnd Factors to Overcome Them.

The presence, and presumably the use, of online computer technology in schools is growing at a rapid rate. Heaviside, et al. (1996) present the findings of a survey of telecommunications use in U. S. public schools. Half of all public schools currently have access to the Internet, and 74% of those not currently connected plan on doing so in the future. Although present in schools, Internet access has not yet reached the classroom. Only 9% of all instructional rooms (laboratories, libraries and classrooms) now have direct access to the Internet. Notably, this is a three fold increase since 1994 (Heaviside, et al, 1996). Among all U. S. public schools, 85% have access to some sort of local or wide area computer network. Public schools average 72 computers in all locations (academic and administrative), however only 14% of all computers in schools have direct access to computer networks (Heaviside, et al., 1996).

Changes in teaching and learning have become subsumed under the general topic of school restructuring. In order for restructuring to succeed in a lasting and significant manner it must address the core cultural relationship of schooling, that of the relationship between the teacher and the student (Fullan, 1993). Implicit is the fact that schools as they exist in much of the country are structurally aligned in ways that inhibit change. The use of time, the requirements of state mandated curricula, and the nature of assessment limit the ability of technology to change teaching in the manner envisioned by Collins (1991) eight trends.

Cuban (1986, 1989) articulates this fear in his book, Teachers and Machines. He argues that computers, like other machines before them, will be used by teachers in ways that supplement, rather than change, their practice. Cuban is not criticizing teachers, instead he presents a realistic view about the constraints teachers face as individuals working within institutional environments. The fact that changes in teacher practice are limited by their environment is particularly true when considering the use of technology. Computer technology, although relatively inexpensive, is a major investment for schools. Many districts have inadequate access to computers, modems and even telephone lines (Honey & McMillan, 1994). Wealthy and poor districts, in a variety of settings, operate in a public arena with different priorities for making decisions about how to use technology. The changes in teaching practice envisioned by many as a by-product of CMC are limited by the institutional and social barriers to change in many schools and districts (Winn & Coleman, 1989).

Barriers to the full adoption of online technology are a significant topic in both the OTA report (1995) and in the survey conducted by Heaviside, et al. (1996). Heaviside et al (1996), summarize the problem as a lack of funding and inadequate access to online resources. The OTA report (1995) is more specific. Although schools are investing heavily in hardware and software, they are not exhibiting the same concern with how technology will be used. There is a lack of adequate training for teachers. Organized training is important because, given the current structure of school, teachers lack the space and time to develop expertise on their own. Furthermore, there is a lack of on-site technical and curricular support for teachers in the use of technology in the classroom (Office of Technology Assessment, 1995). Access is an issue as well. Most online computers are located in offices or laboratories. Teachers need to make special, often difficult arrangements to bring their classes to such places to use the machines. The OTA report (1995) speculates that lack of phone lines in classrooms is due to a fear that teachers will abuse them. Finally the age of computers in U. S. schools limits their ability to be of much use in the curriculum. Although the U. S. leads the world in the number of computers in schools, it falls behind, in the number of modern (16 or 32 bit) computers available (U. S. Congress, Office of Technology Assessment, 1995). Older (8 bit) computers lack the ability to use CD-ROMs or access online networks.

Introducing any educational innovation is a change process that needs to confront the culture of school (Sarason, 1991). Educational technology is no exception (Bowers, 1988). Fullan (1994) has aptly described the process of educational change as a voyage undertaken that is non linear and full of problems. Educational change will not succeed unless the relationship between the teacher and the learner is at the forefront (Fullan, 1994).

Ely (1990) proposes eight conditions that facilitate the successful implementation of educational technology in schools. These include dissatisfaction with the status quo, people with the knowledge and skills to carry out the implementation of technology, the availability of resources to make the implementation work, sufficient time to implement technology and train others in its use, rewards or incentives for those who begin using technology, expectation and encouragement of the use of technology, a commitment to the use of technology by those involved in the implementation process, and evidence of leadership in the implementation effort. Many of these reflect some of the general processes of change outlined by Fullan (1994). Fullan (1994) has argued that change needs to involve the effort and support of both teachers and administrators in order to succeed. Furthermore, teachers must recognize and understand the benefits that will accrue to them if they are to abandon their tried and true educational practices for new ones (Dwyer et al, 1990b).

The Office of Technology Assessment report (1995) emphasizes the importance of human resource development if technology is going to be successfully adapted for classroom use. The report advises school districts to invest as heavily in human resources as it does in hardware and software (U.S. Congress, Office of Technology Assessment, 1995). It advocates the development of a technology plan in which training and support occupy one third of the technology budget. The report presents various methods of training teachers to use technology. One of them is to develop technology rich schools, in which the theme of technology as a teaching and learning tool is acknowledged throughout the school. Another training model is giving teachers computers to use at home, so that they become comfortable with the technology (Wilson,

et al, 1993, 1995). A third model is to train a cadre of trainers that can then serve as training resources for teachers in their schools. Teacher resource centers are another means of providing teachers with support for learning new skills. Involving administrators as well as teachers in technology training can help generate support from principals and other administrators for technological change. Such support, as well as support from parents and the wider community, is essential if adapting to the use of technology in schools is to be successful (U.S. Congress, Office of Technology Assessment, 1995).

Constructivism and Technology

Constructivism as an educational movement is concerned with the learning relationship as it is enacted in the classroom. It describes learning as it should be as opposed to prescribing a method of instructional practice (Richardson, 1994). One problem raised in any consideration of the learning relationship is that of power. In a didactic learning relationship power resides with the teacher, knowledge is transmitted to the student through instruction by an authority. As teaching styles change, power relationships begin to shift. Teachers who assume facilitative roles with their students while using texts will still be accepted as the authority by students (Richardson, 1994). Teachers who are collaborative begin to shed authoritative roles. Collaborative teachers can be seen as co-learners who have embarked on journey of exploration with their students. The goal of constructivist learning should be one in which learners assume responsibility for their own intellectual development. Iran-Nejad (1994) assumes as much when he characterizes an individuals intellectual growth as the journey from an intuitive to a professional knowledge base.

The question that needs to be addressed is the role of technology in stimulating changes in the teacher-student relationship in ways that move from the didactic, through the facilitative, to a collaborative relationship leading to self directed learning. Riel (1994) has written extensively about the impact of technology, particularly online technology, on classroom practice. She argues that technology engenders changes in classroom instructional practice, including a move to more project based, cooperative, and interdisciplinary, thematic learning; and changes in both the structural and organizational elements of schools. According to Riel (1994), the use of technology in the classroom curriculum makes change agents of teachers, administrators and parents. It also has an impact on the organization of the school itself, particularly its use of time, and its assessment methods. Online technology also tends to minimize the isolation of classrooms by opening them up to a larger educational environment. The use of technology, especially online technology, offers opportunities for collaboration among students in classrooms throughout the world, and among their teachers who have the chance to develop professional relationships with peers in other parts of the world (Riel, 1994).

METHODOLOGY

The purpose of this study is to assess the impact of online computer technology on teaching and learning in schools. This has been accomplished through an analysis of participant responses to questions asked in online interviews. The interview questions (see Appendix 1) were designed to collect data that address the two research questions that guide this investigation. They are:

1). Are teachers who use online computer technology in their classroom more likely to exhibit the practices of a constructivist teacher?

2). Which structural or sociocultural elements of school support the use of online computer technology in a constructivist manner?

Online Research

Online interviews conducted as a series of electronic mail exchanges serve as the primary means of investigation in this study. The advantages offered by online technology make it an ideal research tool. Online technology is an ideal communications tool. The asynchronous nature of network communications lends itself to world-wide discourse. Practitioners with access to CMC have the ability to exchange ideas and information using text-based communication, almost anywhere in the world. This lends itself well to the various methods of research.

The use of online survey research is relatively new. Hiltz and Turoff (1978) discuss the possible use of computer mediated communication as an opinion research tool, especially using predictive data gathering techniques such as Delphi. More recently James, Wotring & Forrest (1993) found that online surveys are "fast, relatively inexpensive and allow users to request feedback that can clarify misunderstandings about the instrument" (p. 52). Participants in online research are often self-selecting individuals who subscribe to listservs (Sudamlis, 1992). Thach (1995) analyzes the use of electronic mail to conduct survey research and finds it to be cheaper, easier to edit, faster to administer, simpler to invite participants, a higher response rate' more candid answers and a potentially quicker response time with a wider area of coverage. Honey and Henriquez (1993) report on the results of a national survey of the use of telecommunications in a K-12 setting. Honey and McMillan (1994) used online technology to interview 18 teachers who had participated in the earlier study.

Population and Sample

The population under study is composed of educators who use online computer technology. It is assumed that educators with experience in the use of online computer technology will posses insights into the changes that exposure to online resources will have on classroom instruction, and the relationship between student and teacher. Therefore, this population will have ideas concerning the role of technology in the long-term restructuring of teaching and learning.

Sampling was conducted online in an effort to locate the typical case of an online educator (Lecompte and Preissle, with Tesch, 1995). The typical case in this study is an educator whose commitment to using online technology is made evident by their participation in online educational discussion groups. The sampling process began when notices describing the study were posted on a number of listserv discussion groups, concerned with education. Listserv discussion groups were used to solicit participation, as opposed to being the location of the interview protocol in order to avoid the problems of net etiquette reported by Foster (1994). A copy of the notice is included as Appendix 2.

Thirty-five people responded to the posting. A number of the responses were inquiries regarding obtaining the results of the study when completed. Some others declined to participate when they learned more about the process. The final sample was composed of twenty-five respondents representing schools in 16 states and 6 countries. They include schools that have already adopted online technology, and are experimenting with its use; and schools that are in the process of adopting online technology. Fifteen of the schools are primarily elementary schools; ten are secondary or K-12 schools.

Materials

An interview format for use in a written interview exchange was developed and pilot tested. A copy of the interview format appears as Appendix 1. The interview format allows for in-depth exploration of the contextual considerations involved in decisions to implement online technology, and integrate it into the curriculum. Also included are questions concerning the subject's teaching practice and the support their use of online technology receives from other members of the school community. Recognition that each schools' experience with the adoption of online technology is unique favors the use of an unstructured interview format rather than an online survey.

Data Collection

One of the great advantages of online technologies is that they are asynchronous, overcoming barriers of space, time and location (Harasim, 1993). The speed of electronic mail communications allows message transmission, even overseas, to be counted in terms of seconds and minutes, rather than days and weeks. It overcomes differences in time zones; messages begun in the afternoon in one location are available in the morning in other locations. This lends itself well to the idea of an online interview. An exchange of one or two questions and answers can occur each day. The data in this study, using electronic interview techniques, was collected in a matter of weeks.

The use of an unstructured interview format enabled data collection to proceed in a conversational fashion. In an interview as conversation the reflective element of the conversation leads to new thoughts on the part of the researcher and the subject, leading to the construction of new meanings (Klave (1990), cited in Miles & Huberman, 1995). Questions asked followed the thematic outline presented in Appendix 1, are specifically addressed to the situation and concerns previously expressed by the subject. This technique lead to the collection of a large quantity of highly reflective data from each subject.

DATA ANALYSIS

The data that emerged from the interview process were qualitative, textual quotes, the words of the participants, as they appear on the electronic mail exchanges between the researcher and the subject. These were downloaded into Microsoft Word 6.0, merged into a single text file of questions and answers, and reformatted in order to become compatible with The Ethnographer 4.0, a qualitative data analysis program.

Data analysis was conducted according to the guidelines of the Constant Comparative Method (CCM), first described by Glaser and Strauss (1967). The goal of CCM is the emergence of theory from data, derived through repeated review of the data, each time examining it in order to locate common thematic content. The CCM involves repeated reviews of the data, initially to understand the story that the subject is telling, and later to code the data in order to construct the themes inherent in the story. The thematic elements of each set of data are compared and analyzed for similarities and differences, combining some themes and deleting others. The review an analysis continues until the researcher is able to theorize about the meanings inherent in the data through "perceiving, comparing, contrasting, aggregating, ordering, establishing linkages and relationships, and speculating" (Lecompte et al., 1995, 239-240). Themes that emerge from the analysis may or may not be congruent with the research hypothesis stated earlier. If they are congruent, theory will be supported; if not, new theory will emerge to explain the discrepancy.

Establishing the validity of qualitative data, especially data of this type that was gathered online, differs from the validity of quantitative data. In qualitative data it is appropriate to speak of the interpretive validity of the data (Altheide & Johnson, 1994), the extent to which the analysis can be supported by other sources. Two efforts were entered into to determine the interpretive validity of the data. First, site visitation, allowed the researcher to develop a visual sense of the site, the people, and the work being done there. The second, member checking, involved having the subjects review the interview transcripts and the things that have been written about them, in order to determine if they are being correctly represented. Given the widely dispersed study sites, conducting site visits was difficult. Visits were made to five sites, in Arizona, the District of Columbia, Maryland and New Jersey. While there, conversations were held with the subjects, their students, and their administrators in order to place the data from the interview in context. Member checking was greatly facilitated by the use of online technology. Once the interviews were organized into a complete transcript they were sent, via electronic mail, to the subjects for their review. Once they read the transcripts the subjects returned their comments to the researcher, also be electronic mail.

The analysis of the interview data led to the construction of themes that provide a tool for understanding what the data contain. The themes emerged from repeated readings and coding of the interview transcripts. They represent the ideas, beliefs and practices of the study participants. A list of the

themes, how they are defined, the sub-themes and the research questions to which they relate appear in Table 2.

The following presentation of the data begins with a discussion of Access, the distinction between those schools who use online technology effectively and those that do not. These two groups will be compared and contrasted in order to serve as another analytical device for understanding the data. This section will be followed by a discussion of the themes in relation to each of the two research questions.

Access

The availability online technology in the school has typically been used as the measure of how widely online resources are used (U.S. Congress, Office of Technology Assessment). It quickly became apparent while analyzing the data, however, that the availability of online technology alone does not determine the use to which it is put. A new, broader concept, Access, is used to distinguish between those schools in which online technology is used most effectively, and those in which it is not. Access encompasses the availability of computers, but it also includes the location and type of the computers, modems and phone lines, as well as the restrictions placed on their use by students and teachers. As such, it addresses a more significant distinction that divides the schools in this sample: the ease with which teachers and students can use online technology.

None of the schools represented in this study were technologically poor, however they differed in the manner and extent to which online technology pervades the school (see Table 4). High access schools are those in which the use of online computer technology is fully integrated into the school curriculum. Schools are connected by a local area network (LAN) with stations in each classroom. The LAN offers direct in-school communications capability and access to electronic mail and the World-Wide Web (WWW). Teachers in high access schools are able to easily use online resources with their students. Students have the ability to use online technology and the space in which to work on projects that originate online. All of this takes place within a school climate that encourages and supports the use of online technology. In contrast, low access schools are not connected by a LAN and online technology can only be obtained from a single site such as a laboratory, library, or media center; teachers need to schedule use in advance. Use of the accessible site may be limited to the few hours a week when it is not otherwise scheduled, or it may contain other restrictions such as limits on noise or absence of good work space. Students in low access schools have restrictions on their ability to use online resources. Missing as well in low access schools is a climate of support for the use of online computer resources in the classroom.

Question One: Online Teaching and Learning

Question one is concerned with change. It assumes that teaching practice is changing from a predominantly didactic mode of practice towards a more constructivist paradigm, under the influence of online computer technology. Learning, it is assumed, will consequently be recognized as a constructivist activity, something students do themselves within the context of the classroom. Change is a continuous, unpredictable process, in which the beginning is unclear and the outcomes are unseen (Fullan, 1993). It is both an organizational and a psychological phenomenon, in which processes and beliefs must change (Sarason, 1991). Discrete measures that seek to describe the process of change are flawed because change is uniquely contextualized. Therefore attempts to describe a predictable path of change are unrealistic.

The data that this study has generated derives from a series of dialogues between the researcher and the subjects in online interviews conducted over a span of several weeks. The data were coded and analyzed, particular passages were marked because of the way they illustrated the ideas of the subjects. Selected passages were analyzed individually and compared to other similar passages from both high and low access schools. This allowed for distinctions to be made among schools with a low degree of access to online technology, and those schools whose access to online technology is relatively high.

The data on teaching and learning have been organized into four connected themes: Use, Teacher, Student, and Impact. These themes will be examined for differences between high and low access schools. The first involves the overt use to which online technology is put in the classroom. How technology is used is the outward indicator of how it is integrated into the school curriculum. The second theme involves teachers, their beliefs and practices. The ways teachers organize the classroom, interact with the students, and think about themselves and the group are indices of the changes that teachers are undergoing as professionals. The third theme involves students and, most particularly, student learning. The way students interact in the classroom, their level of interest and enthusiasm, and the extent to which they direct their own learning will be considered. The final theme involves the impact of online technology in the classroom. Impact in this sense refers to changes in teaching and learning.

What follows is a discussion of each theme, illustrated by quotes taken directly from the data. Whenever possible, subjects' words will be used to establish the meaning of the theme. The discussion of each theme will include contrasting opinions that illustrate the differences between teachers at high access and low access schools. Finally, the section will end with a characterization of the impact of online technology on teaching and learning in the classroom.

Use

Examining the ways in which online computer technology is used in schools, as reported by the educators who participated in this study, presents an idea of the ways in which each participant views themselves as an educator. The amount and type of use to which online computer technology is put varies according to its accessibility at each participant's school. Although each of the educators involved in this study has access to online computer technology at their school, the amount of access available to each varies by location and type. Some educators in schools that had very limited access to online computer technology managed to obtain online access in their classroom, which allowed an exploration of the capabilities of online education. Students were often involved in online projects in these classrooms.

> *In October we were part of the SWOOPE (Students Watching Over Our Planet Earth) acid rain project. We will be doing some graphing projects from the data we collected from other schools. Toni, Low Access*

> *Our entire seventh grade is also part of a Genetics project. We are working with 18 schools around the country on this project. We are all doing the same labs and collecting the same data and our results will also be placed on the web. Rita, Low Access*

Teachers, particularly those in high access schools, think a great deal about the ways that online resources can be integrated into the curriculum. Many of their ideas come from their involvement in online educational discussion groups.

> *For me, the online sources I read regularly are a kind of professional magazine, necessary or at least helpful for professional development, keeping abreast of new ideas and information in the areas I'm most interested in making connections beyond my local school and community. Toni, Low Access*

> *I currently get my projects from Labnet on AOL, Scholastic Network on AOL, and from listservs such as Kidsphere, Middle-L, and Hilites. Rita, Low Access*

Educators with a high degree of access describe online technology as a vehicle through which part of the curriculum is enacted. They explore online discussion groups and develop projects with other teachers in classrooms located in different parts of the country or world, which they enact with their students.

Kindergarten students just completed an on line Jabberwocky project that now takes up a floor to ceiling bulletin board. Students wrote and followed directions to make a Jabberwocky that had parts from 18 states. Sandy, High Access

Online activities do not necessarily mean that students are working directly with computers. Students participating in online activities often work together off-line and report about their activities online.

One teacher recently participated in a Read-a-thon where her students spent the day in our Library with their blankets and stuffed animals (these were 6th graders!) They took turns reading to each other, many classes, individual students and teachers dropped in during the day to read. All the while, they were signed onto an AOL Chat room where authors and students in other schools were conversing about the books being read in their schools. Deb, High Access

One of the more innovative projects described by the subjects placed a popular children's book character on a round-the-world adventure, in which the students in each location were responsible for describing his activities while he visited their community.

Cyber Travels of Flat Stanley: Classes around the country are learning from each other because of the adventures of Flat Stanley, a storybook character. He is sent out to classes in other states and those classes take him to historical sites and document his visits with pictures and reports. All of the information gathered will become part of a Web page about his travels. This makes learning about our great country just a little more personal. Sandy, High Access

Some teachers integrate the various aspects of the curriculum and use online resources as a source of information and a repository of curricular information.

Because the classes are integrating math, science, history and all other curriculum areas into larger topics, it has been a natural extension to bring in the Internet and take advantage of the wealth of resources. Recently, in the last year, many of the staff are now organizing projects and posting to the Net to work with other schools and then culminate the project with a new home page. This really seems to capture some of the power of the telecommunications. Sandy, High Access

Teachers' conceptions of how online resources can be used affects the material they find online and how they use it. Some teachers take advantage of online projects in order to diversify the curriculum and provide new themes through which their students can learn.

Students also explored the Arctic, Antarctica and the Mayan ruins with explorers that they could interact with by questioning. I guess the biggest different is that information is current, exciting, and allows the student to access information as a learner not as a sponge. Liz, High Access

The use of online computer technology affects the ways in which teachers view themselves and their roles. No longer are teachers who are able to communicate with online technology consider themselves to be isolated practitioners.

I am not isolated. Teachers and I communicate as we integrate the technology into the curriculum. Isolated no, leadership yes. Carol, High Access

The degree of access to online resources clearly affects the use to which it is put. The presence of a local area network (LAN) in a school does not guarantee ready access to online resources. LANs with mathematics, science, and reading software can be used with the students, but they often serve as little more than electronic work-books. LANs offer access to CD-ROM resources in the library, and provide a vehicle for school-wide electronic mail. Schools with LANs sometimes have one modem that can be used to connect to an Internet service provider. Using this connection, teachers can join a commercial online

curricular project, such as the National Geographic Kids Network, or develop electronic mail relationships with teachers and students in other schools. The access involved in these projects, however, is limited to that of the teacher and the goodwill of those who controlled the space in which the accessible computer is located. Teachers involved in such projects personally send messages and download responses for their students. These teachers often complain of the time involved, the cost of participating in commercial curriculum projects, and the difficulty of adapting these online commercial curriculum projects into their own plans.

> *I am no longer involved in the Learning Circles. I was part of the last circle and then it moved to the I*Earn network. There is a charge to belong to that network of $250. I have managed to find better projects on my own. One problem with the Learning Circle was that I could not integrate the project into my curriculum. I had requested a circle to discuss the environment, but ended up with teachers of different disciplines. Rita, Low Access*

In summary, the use to which online computer technology is put in a school is perhaps the best indicator of the changes that have occurred in the curriculum. Some teachers explore online, seeking resources, projects and ideas for their classes. Other teachers' use is limited by structural barriers such as easy access, cost and the attitudes of those at school.

Teacher

The educators participating in this study are all involved in the process of changing themselves professionally. They are neither strictly didactic in their practice nor are they wholly constructivist in their beliefs. They are arranged along a continuum of change in teacher practices that stretches between an objective belief about human knowledge and learning, and student-centered teacher practices.

The theme of Teacher is composed of four major sub-themes including beliefs, classroom management, assessment and teaching style. Educators in this study articulate a large variety of beliefs about themselves as teachers, the use of technology, their conceptions of children, and their perceptions of education. These will be presented, recognizing that self conceptions are often espoused theories and are less likely to be an accurate reflection of beliefs than observed behavior (Argyris and Schon, 1974). How teachers describe classroom management and their conceptions of authority, power and control, often reveal their implicit beliefs about children. Their language is also indicative of their attitudes regarding assessment revealing what they are assessing and how they are doing it. These are important clues for discovering their views of learning. The fourth sub-theme, teaching style, is constructed from a series of codes (see Table 2) directly referring to the respondents' answers to questions asking them to describe typical, extraordinary, and terrible days with their students (see Appendix 1).

These educators possess a strong, positive self-image. Among them are teachers who are facilitators, teachers with high expectations of their students, and people who are process-oriented, innovative, demanding and fair. Some teachers are able to view their students as children first

> *I became a far better teacher after I had children of my own. I understand more what it means to be a child. They are not as deliberately manipulative as I once thought. I now see them as having to deal with a great deal of emotionally stressful "stuff" in their lives, and I treat them as I hope my own kids get treated. With compassion, patience, love and understanding. They are people first, students second. Juanita, Low Access*

and consider themselves part of a community of learners.

> *I characterize myself as a teacher as a learner, at least one with the attitudes of a learner but one who happens to know more and different things about the topic than the students do at the moment. To that end, I try to cultivate a community of scholars - as much as is possible at the high*

school level - with the hope that at least a few students will get a glimmer of the joy of learning. Phyllis, Low Access

Although a positive self-image is characteristic of all teachers interviewed, their beliefs about the use of online technology vary based on the degree of access available to them in the school. Teachers in high access schools uniformly value online technology as a tool to enhance communication, while some in low access schools are more concerned about the possibility that their students will find inappropriate material online.

Characterizations of the subjects' conceptions of classroom management were developed from a series of questions which asked them to describe a typical, extraordinary, and terrible day with their students. Their responses to these questions, particularly the third concerning a terrible day, reveal teachers' conceptions of their students, their sense of responsibility for classroom climate, and their ideas about power, control, authority, and management. Many of these teachers take responsibility for the terrible days in their classroom, believing it is their lack of preparation, mood, or tardiness that lead to the situation. They speak of defusing the situation and restoring communication in the class. Others with larger classes and lack of support are overwhelmed by their students and blame their lack of self-control for terrible days.

Teachers' choice of evaluation and assessment strategies vary as well. Some test for objective knowledge, while others who use a more project-based curriculum seek means of assessing constructed knowledge. The methods used vary across a continuum of assessment practices. A number of teachers base their assessment on quiz, homework, and project grades. One teacher uses tests to measure progress in learning. A large number of teachers, mostly working in higher access schools, use narrative reports, some for specific projects, and others involving the voices of children in deciding the standards. Their goal appears to be tailoring the evaluation to the individual student.

The evaluations reflect the concerns that seem to be most important for that individual. Carol, High Access

Many assessments of teaching style emerge from the subjects' descriptions of typical, extraordinary and terrible teaching days. When asked to describe what was occurring in the classroom in terms of what both they and their students were doing, what they had intended to have happen in the classroom that day, and how they would evaluate what had transpired, their responses varied. A number of them, particularly those in lower access schools, engage in direct, teacher centered instruction, lecturing for the entire lesson, or lecturing to establish a purpose of a lesson or a theme. Others, typically in higher access classrooms, roam the room, helping, supporting, and serving as a resource for their students. A number of these teachers use problem-based methodologies and had fun working with their students in a laboratory setting, where activity is directed towards answering a guiding question. A few teachers seek online projects that attempt to engage their students in high order thinking.

I think it's all about higher level thinking, critical thinking, problem solving. And collaboration. Experiences that successfully nurture and require these kinds of mental processes will serve these kids all of their lives. Juanita, Low Access

A number of these teachers conceptualize learning as an individual quest for knowledge.

Because these are individuals with individual quests lots of topics are individual and lots of ways of reacting responding performing demonstrating knowledge etc. are individual as well. Carol, High Access

Some teachers at lower access schools define success as completing the day's work, and getting the job done correctly. Others complain that students no longer memorize things. Some low access teachers view teaching as fixed and objective. Others of them rely on text-based instruction.

For the most part most of our teachers are book driven. Rita, Low Access

In considering where teachers appear on a continuum of educational practice one can use their language as a means of assessing their core beliefs about the nature of knowledge, as opposed to how they would prefer to be seen (Argyris & Schon, 1974). In describing their typical, extraordinary and terrible days teachers reveal their attitudes about classroom management, assessment and teaching style. These statements demonstrate that a number of teachers, particularly those in higher access schools, possess a constructivist view of knowledge. This is particularly apparent in their ideas about assessment and their educational practice.

Students

The theme of Students is directly concerned with student learning. As constructed here, student leading involves coded segments of interview transcripts that refer to learning in general, authentic learning, student engagement, reflection, visual and verbal learning, student empowerment, and self-directed learning. These constructs describe teachers' conceptions of student learning and help establish if there is a difference in opinion among those who work in schools with limited access to online resources, and those whose access is virtually unlimited.

Learning is the business of education. As educators we expect students to learn and work to ensure that they have the opportunity to do so. But conceptions of learning are changing as conceptions of knowledge change. While many educators still believe in an objective world in which learning facts is important, many educators are beginning to accept the idea of individually constructed knowledge of the world. It is no longer enough to memorize facts.

Students memorize and forget a tremendous amount of information, but real learning only seems to occur when kids are interested in and care about a subject. Paul, Low Access

Learning in a social setting has also become a popular idea amongst those who conceptualize knowledge as socially constructed.

Students are much more involved in their own learning with technology. They work better together on projects and use those social skills that are part of cooperative learning. Liz, High Access

The ability to communicate with others in distant locations exposes children to ideas other than those of his/her teacher.

Where it is essential is in the progressive notion of connecting a child's education to his world. Using the computer brings the world into his or her education in a very real way. The reader, or information provider, or whatever is not just the teacher. Carol, High Access

Online technology brings resources from around the world into the classroom. It is a vehicle for enacting curriculum in ways that have previously been theorized.

This is the "discovery method" writ large in society. It fascinates me that finally we have a working demonstration that this "progressive" educational technique is an effective learning tool. Liz, High Access

Authentic learning is the belief that student learning is enhanced by exposure to real, as opposed to abstract, problems (Brown, Collins & Duguid, 1989). Online sources offer opportunities for students to work with real problems, real data and communicate with real people who have lived through real situations.

> *Our students didn't understand about the power of tornadoes until they received an email message from one of their key pals in Kansas whose town had just been struck by one. Andrew, High Access*

Access through electronic mail to people who are willing to communicate with students makes the experience more interesting and authentic.

> *I suppose that the communications which are opened to all corners of the world would have to be the most significant at this point. The power of having students learn from those who are living in the places we are studying has to be significant in impact. Sandy, High Access*

Authentic information gained from those with first hand experience allows students the opportunity to construct an understanding of what it is like to live in different circumstances, elsewhere in the world.

Students enjoy interacting with computers and working online. They want more time with computers than the schedules at most schools allow. The use of technology appears to enhance the speed with which all student learn, and the extent to which they are focused and engaged.

> *Projects are a particularly fascinating aspect of online work that students appear to enjoy. This is one of my favorite points in teaching. I love this project and I love the way it engages kids in a very challenging project that, when finished, really seems to them to be the culmination of weeks of hard work. Paul, Low Access*

No longer is student engagement conceptualized as simply time on task; now it is described as enthusiasm and enjoyment.

> *Students want more and more computer time; they look forward to lab time and some complain they don't get enough time in their classrooms. Juanita, Low Access*

Online technology is also a vehicle for empowering learners as they see their own work valued and placed on display on the WWW.

> *I must mention the power of students publishing home pages and seeing their work out on the Web for the world to see. It certainly gives publishing a significance. Sandy, High Access*

The ability of the WWW to combine video, audio, animation, and text in one place makes it a varied, enticing multi-media learning environment that stimulates all the senses. In interacting with the WWW one engages in both visual and verbal learning. Most participants found the WWW to be a varied and interesting environment, although two participants, both in a lower access schools, felt it pretty, but not substantive enough for serious academic work.

Access to computer technology empowers students. The speed with which they learn to use computers gives them a feeling of confidence and self-esteem. In many cases, teachers actually learn how to use programs from students who have mastered them at home. Computer technology enables all students, no matter their ability, to succeed.

> *Technology is also an equalizer; inclusion students can perform as well as regular students.* Liz, *High access*

Online technology allows teachers and students to become learners together, using electronic mail as a gateway to finding all sorts of information.

I see teachers using online resources as an added research tool. I see e-mail use giving students and teachers the power to ask more questions, because the beauty of e-mail is the ability to get answers. Miriam, High Access

Teachers in high access schools accept the idea of self-directed student learning. Self-directed learning is the ability of students to make decisions about how they will work. It is apparent that online technology is abetting the process of self-directed learning.

The biggest difference I see is that the student is in control of his her own learning. They learn that there is not always one right answer to their questions. Liz, High Access

Online technology provides learning for all students; it meets the needs of many different learning styles and allows students to feel that they are in charge of their learning. Max, High Access

Online technology offers students and teachers more choice about what they will study and how the will study in the classroom.

And that is why technology is such a gift because it empowers my students to have more control of their learning than they have every had before. Carol, High Access

Self-directed study learning can lead to more engaged students, involved in more creative work, constructing their own knowledge as they interact with their environment.

Students DO IT. They are fully engaged, concentrating, and even coming up with their OWN IDEAS. I can almost SEE the synapses in their brains firing away, creating new neuronal pathways as they problem solve- the atmosphere in the lab is electric. That kind of experience makes me feel great. I become unaware of the passage of time and want to jump for joy, saying, "YES YES, let's GO with your idea, let's figure out how to do that!" Deb, High Access

Online technology has clearly had an effect on student learning. The data indicate that teachers with a high degree of access are enthusiastic about the use of online technology in the classroom. They speak of the speed with which their students learn and their interest and excitement about learning. Teachers describe the change towards more inclusive classes, and teaching methodologies that tend towards self-directed learning. Although some teachers express reservations about the use of the WWW, they generally describe their experience with online technology as one that stimulates student learning. Teachers in low access schools have a vision of the changes that will come about once online technology is fully implemented in their school. But a number of them are still involved in teacher-directed activities that seek to control the knowledge that students learn.

Impact

The impact that online computer technology has had on teaching and learning as articulated by the subjects of this study ranges from the enthusiastic to the critical. Most subjects, especially those in high access schools, assess the impact as beneficial, focusing on the role of online computer technology as a communications tool and on the vast amounts of information available online. The information available was also the basis for many of the concerns expressed about online technology in the classroom. A number of teachers worry about the possible concerns parents might have of their child encountering inappropriate content. Others, particularly those in lower access schools, worried about the quality of the content itself and students ability to adequately evaluate it.

The positive impact of online technology is apparent in both students and teachers in high access schools. Students generally enjoy working with online computer technology, particularly if they are involved in working on a project. There are changes in teaching style towards a model that uses a problem solving

approach. Working with real world data, available through the use of online resources, lends authenticity to the teaching and learning process.

> *The most outstanding benefit, without question, is the access e-mail across the Internet has provided to real people engaged in real work who are willing to communicate with students. (I'm thinking of the scientists who answered a few direct questions on a one-time only basis, the college professor who read and replied to responses to literature for a whole school year, the scientists from Journey North and the Jupiter probe who shared data as they received it.) This connects their education, in students' eyes, to the real world of real work and makes it meaningful. Carol, High Access*

> *Our French class has been in the past two days reading Le Monde and looking for other French resources. Deb, High Access*

Students' writing ability appears to improve as they write for an online audience.

> *Technology has made the writing process easier because revising, editing and conferencing can be done quickly with the child at the computer. Liz, High Access*

The ability of students and teachers to communicate with others not only lends authenticity to their work, but facilitates project planning.

> *The most outstanding benefit is communication. For the students they can reach other students and learn from them. This would be a much more difficult and costly task if it wasn't for on-line technology. Information can be obtained much easier. Rita, Low Access*

> *But through online technology, we can communicate with colleagues, friends and family. The dialogues, no longer dependent on finding a time when we can meet or talk, are more frequent. I just finished submitting a proposal for my math team to present a workshop. In the past writing one of these proposals meant 6 phone calls each round of revision. Now we do almost all of it by e-mail. Much quicker in the long-run and more efficient. Deb, High Access*

Online computer access offers students and teachers the ability to find and use an enormous number of current resources.

> *We also have access to more resources than our school could ever afford. And we can also do things in a timely manner. Deb, High Access*

> *Having access to telecommunications allows teachers and students the opportunity to access current information quickly, participate with others in projects, and move beyond the prescribed curriculum to new areas of interest. Liz, High Access*

The appropriateness of much of the content available online, however, is of concern to a number of the educators who participated in this study.

> *The drawback that worries school officials is the same strength presented by this tool – its open-endedness. Kids can get to places that will upset their parents and maybe even upset them. Yet if they are to learn to use the tool, it is not possible to monitor them at every minute. That would defeat the whole idea. So that is a dilemma. Deb, High Access*

Teachers worry about what parents will think, particularly as stories of inappropriate content appear in the popular press. They anticipate the creation of an appropriate use policy by their school board, and have adults supervise WWW searches to ensure that students find the intended material. Some teachers have

even begun to employ software tools that place limits on students' ability to access objectionable WWW sites.

> *I have employed a software program to help screen inappropriate sites. "Surf Watch" has worked well and kept everyone out of trouble - even the high school and middle school kids who visit our lab. There have been a few times where these older students have attempted to access these sites. It is impossible to monitor everyone in the lab and to know what they are doing. I have used this software to protect myself and the school from legal problems that can result from students (minors) being exposed to WWW sites that are "offensive." Andrew, High Access*

The quality of the content available on the WWW is also questioned. Information on the WWW may be visually pleasing, but, according to some participants it lacks the depth of information that can be found in text based sources. Educators are also concerned about students' ability to evaluate the material found online. At least one participant wondered about the impact of such a visual medium on student literacy, and on students' ability to analyze and evaluate information.

> *I am concerned about the isolation that computer use often entails. It does not seem to me, as I watch my classes work, that the use of online technology has fostered working together. I am concerned that much that has been developed in terms of authority systems over the past 100 years (selection media, reviewing for library materials, refereeing for academic journals, and the like) does not lend itself to a system of universal access and information such as the Internet. Obviously this has its good side but don't see as much emphasis on teaching students to evaluate the information they get as I do on teaching them to "access" it. I'm concerned, too, about the emphasis on the picture over the word. The web is more popular than gophers because of the ability to use pictures, etc., but I find it much slower, actually, as an information source. But I read. My students look at the pictures and move on. It's almost impossible for me to imagine the future of education, technology changes so fast and we are obviously just at the beginning of on-line tool development and on-line information systems. Deb, High Access*

The educators participating in this study generally think that the impact of online computer technology is positive. They cite the enhanced ability to communicate with others and the quality of real information available online as factors that contribute to a heightened sense of authenticity in student learning. Many participants, however, particularly those with limited access to online technology, expressed concern about the appropriateness of online material, ways of monitoring student access, the quality of information available online, and students' ability to adequately evaluate it.

Access revisited

The distinction considered here is somewhat different from that discussed earlier; it is concerned with the classroom use of online technology and the way it influences teaching practice. The data suggest a striking difference between teachers working at high access schools, in which the classroom use of online technology is fully integrated into the curriculum, and those teaching at low access schools where the use of online computer technology is typically available, albeit with some difficulty. Although all the participants in this study have personal access to online technology and all espouse a belief in constructivist practice, a marked distinction between teachers in high access schools and those in low access schools becomes apparent when close attention is paid to their classroom practice. This distinction is most apparent when considering the degree to which teachers seek to control the learning environment.

A number of teachers in low access schools are preoccupied with classroom management. The are particularly concerned with maintaining order in the classroom in order to convey knowledge to their students. These teachers emphasize self-control.

> *I am still trying to convince the children that they must exercise self-control now and in the future if they hope to be successful in their chosen careers. I guess I'm just too old to change my thinking*

that grownups are supposed to be giving the guidance and direction-- even structure--to help the children learn how to be successful and independent. Lani, Low Access

A number of teachers have adopted an authoritarian or disciplinary role that they think will train their students to adapt to a well ordered system of classroom behavior.

Some students just will not work with me because of my authority in the classroom or because of my expectations. I have had several students that absolutely hated me as a freshmen and I still converse with them after three or four years out of high school. Once they discover that I am there to do a job and I will do whatever it takes to meet the demands I put on myself they usually come around. They also see that everything I ask them to do has a purpose. They discover that there is very little busy work in my room. Lisa, Low Access

These attitudes are indicative of a conception of students as passive learners, and a vision of teachers conveying knowledge, as if the were filling an empty vessel (Friere, 1971)

Classrooms in high access schools are active, involved, busy places in which students and the teacher are constantly interacting with one another. The data indicate that teachers in most of these schools believe in self-directed student learning. Self-directed learning implies that the individual student is making decisions, within the context of classroom and the curriculum, about what it is he/she will learn and how he/she will go about demonstrating their learning. Self-directed student learning assumes that individuals construct their own understanding of the world through their interaction with the environment.

The use of online computer technology in a classroom context facilitates self-directed student learning by providing an interactive environment in which students have the power to participate on an equal basis.

On-line technology provides learning for all students; it meets the needs of many different learning styles and allows students to feel that they are in charge of their learning. It's the wise teacher that directs this type of learning because she he is creating a true group of new learners- not just sponges. Students also like anything connected with technology and learning takes place faster when students are involved in what they're doing. Technology is also an equalizer; inclusion students can perform as well as regular students. Students stay focused and are excited about what they are doing. Liz, High Access

The interest and enthusiasm with which students interact with classroom computer technology is indicative of the learning that is taking place. Access to classroom-based technology empowers students by allowing them to control a significant aspect of their learning environment. Students who lack such access have yet to experience the freedom it offers.

All of the teachers involved in this study are arrayed along a continuum of practice from didactic to constructivist teaching. They are all interested in the potential for change in their classroom practice that online technology offers. Those who are fortunate enough to work in high access schools recognize the uniqueness of their position.

I know how very fortunate I am, here...I often feel like Cinderella after being rescued by the Prince. I taught in a public school district for 20 years and got pretty bloodied in attempts to "make things happen" with technology. First of all, I got this job from an Internet announcement (becoming more common now...pretty rare in 94 when it happened!). I saw an advertisement that began with "Granite needs sculptor" and described a need to develop a "cutting edge plan" and to integrate technology at an independent school. I went for it...and apparently was what they were looking for, as here I am. Lilly, High Access

The teachers who work in lower access schools are most likely representative of the majority of all teachers. Some of them tend more towards constructivist practice than others. Those who do reflect a school culture in which new ideas and practices are accepted and encouraged. Those who are still closer to the didactic extreme of the continuum may espouse constructivist ideas and look forward to the use of online technology in their classroom, but still exhibit didactic tendencies in their practice.

> *It will help me deliver a more individualized program, and it will help me give it to the students in a different format, but the bottom line is are they learning the skills. Lisa, Low Access*

All of the teachers characterized in this way work at schools in which there is little support for change.

In Summary: Characterizing the Impact of Online Technology

The classroom use of online computer technology engenders constructivist change in teachers and learners by exposing them to a wider array of ideas and learning experiences. The primary difference between online technology and non-networked computers is its use as a medium of communication. Connecting a classroom to online resource ends its isolation, places it in contact with other classrooms in different parts of the world, and enables it to participate in an ever-expanding body of educational programs that offer opportunities for authentic learning experiences lacking in traditional classrooms. The impact of greater exposure to outside resources provides more stimulation for students, encouraging them to pursue their own ideas, and supporting their individual construction of knowledge of the world.

Although their is a clear relationship between a high access to online computer technology and changes in teaching and learning in a constructivist manner, it is impossible to say at this time that technology has led to the change. Each of these high access schools possesses a culture and a climate that supports innovation and change. The elements of this culture and its relationship to the use of online technology are the topic of the upcoming section.

Question Two: The Cultural And Sociocultural Context Of School

It has previously been established that the underlying question concerning the classroom-based, curricular use of online computer technology is one of change. Previously this change has been discussed in terms of teaching practice and learning, specifically a movement from a didactic mode of teaching, with its underlying assumptions about how people learn, and a constructivist model which assumes that individuals construct meaning for themselves. In this section the change under consideration is with the context in which the curricular use of online computer technology occurs. Question two asks, "Which structural or sociocultural elements of school support the use of online computer technology in a constructivist manner?"

The assessment of the structural and sociocultural elements of school which support the use of online technology was one of the major goals of the online interviews. The structural elements can be summarized as those differences between high and low access schools that have previously been discussed and appear in Table 3. The more difficult problem is to isolate those elements of leadership, professionalism and process that comprise the sociocultural aspects of the school. The data that enable this assessment to be made came from a series of questions that asked subjects how the decision to invest in online technology was reached, the type of training and professional development they received, their relationships with colleagues and administrators, and the role of parents and the larger community in the school (See Appendix 1).

What emerged from these questions was the discovery of an ideal developmental process of change. The process begins with a decision to invest in online technology, leads to the ongoing process of planning, purchasing and installing new equipment, proceeds to training and staff development for the professional staff, and culminates in ongoing technical and curricular support for the use of online technology in the classroom. The most highly accessible schools represented in this study approximate this

process. Most others are somewhere in the process, with the least accessible schools just beginning the administrative decision making process.

Fullan (1993) reminds us that any change process is continuous and unpredictable because it involves the core beliefs of people and their practices. People adapt to changing situations before they adopt the change as something that they use on a regular basis. The extent to which online computer technology is fully adopted by the professional staff of the school is one measure of accessibility. A school embarking on this path can succeed if as much attention is paid to the needs as of the individuals who will be working with online technology as is paid to the design of the computer network and the hardware and software that will be used with it (U. S. Congress, Office of Technology Assessment, 1995). The result of a conscientious process of implementation is a climate of acceptance in which the use of online technology is a normal, natural part of the overall school environment.

Climate will be used here as a theme to organize the various, widely ranging sociocultural elements of school. Specifically, climate refers to the way things are done in school or the classroom, and includes the school culture, the social structure within the school, the various actors in the school, and their relationship to each other. Allied with climate and subsumed within it for the purposes of this discussion will be a leadership theme called administration and a process theme called implementation. Administration concerns the role that the administrator and educational leader plays in the climate of the school and in the implementation process. Implementation is concerned with the process by which online technology came to be used in the school. Topics considered under implementation concern training, adaptation, planning, consultants, decision-making and funding. The discussion of these themes will be illustrated with quotes from the subjects. Whenever possible, the quotes will be used to allow the subjects of the study to tell their own story. The section will close with a demonstration of the relationship of climate to access.

Climate

Descriptions of what occurs in a particular organization are alternatively referred to as climate or culture. Although the two are often confused, they are distinct entities. Culture refers to the way things are done within a particular context. Climate can best be understood as the atmosphere that pervades the organization. Climate is the environment in which the culture is enacted, ideally as a dynamic, stimulating and constantly evolving entity. As such, culture is both an architect of climate and a result of the climate in which it exists.

Climate is an atmospheric variable whose presence is felt everywhere from the tone of the interactions among students, teachers and administrators, to the sense of community that exists within the school. The school community as constructed here involves school staff, the student body, and their parents. The language used by participants to describe their interactions in the school is an accurate window through which to view the school climate.

A positive school climate is one in which interactions among students, teachers, parents, and administrators are supportive and challenging. Some subjects speak of the respect that underlies all interactions, the level of collaboration and communication among school staff, and the importance of student involvement in their own learning.

> *This is an independent school. We don't get in each other's way in teaching as a general rule. We're expected to know what we're doing and respect each other...I have never heard a single objection to what I do with the sixth grade. Carol, High Access*

Respect engenders a pattern of collaboration and communication among the staff which overcomes teacher isolation.

> *Isolation is no longer an issue among our staff-unless the few that want it to be that way. With site based management, all the staff development we've done, and all the planning needed to make things work, there are few that don't collaborate and share projects, plans, etc. Liz, High Access*

Administrators in schools with a positive climate cede power to the staff, take their wants and desires into consideration when developing the school schedule or otherwise organizing school activities.

> *Classes are organized by the principal with teachers given three choices each year. We've had two teachers work with the same kids for two years and then move down a grade; guess we've tried just about everything. Scheduling is tough with the Title I teachers, Inclusion teachers, art, music, physical education, library, computer and 3 lunch periods. We try to have grade levels have planning time together and it works most of the time. Kindergarten is usually the most flexible as far as scheduling. Liz, High Access*

The culture is one in which teachers work together and enjoy spending time with one another.

> *Well, our staff is very close and used to teaming and meeting on every subject. We are a site based school and so all teams are cross grade level and subject matter. Sandy, High access*

A positive school climate enables learning at all levels to be conceptualized as something with which individuals become more personally involved.

In contrast, a negative school climate is described as being devoid of support and collaboration. Teachers describe themselves as isolated from their peers and lacking coordination and support. The workplace is often divided into cliques. Teachers conceive of their students as intellectually lazy and the cause of severe disciplinary problems. Some schools lack grade level coordination among teachers, who are characterized as competitive and isolated from one another. Because completion of the curriculum is paramount, new innovations are sometimes met with suspicion. Students are viewed as a group to be managed and administrators, although they talk of support, offer little.

> *I would say that the administration would probably feel that they are really supportive of computer technology. I suspect that the majority of teachers would disagree Paul, Low Access*

Another aspect of climate is the role of parents as part of the larger school community. Most schools have an active core group of parents who participate in PTA, serve on school committees, and participate in fund raising activities.

> *There's a core group of parents who are usually the ones that attend SAC (School Advisory Committee), run the fund raisers and coordinate volunteer helpers. We did have more parents than usual (around who volunteered to help in classrooms, library and lab. Title I is offering $2500 this year to the parent group for them to come up with a plan for its expenditure. Liz, High Access*

Active parent communities occasionally provide financial support for the acquisition of computer hardware and software.

> *We have had parents be a little more actively involved, by donating hardware or software, or advise of one kind or another. Paul, Low Access*

Many of the higher access schools are magnet and other specialized programs which are designed to provide a more stimulating educational environment for students. Such programs attract students from all over the district. Some teachers and administrators at these schools are frustrated in their efforts to stimulate closer parent involvement because its difficult for parents, many of whom have low or moderate incomes, to attend school functions.

Another factor is that many of our parents live quite a distance from school; it's one of the downfalls of the magnet program. Schools are not longer neighborhood schools and transportation can be a problem. Liz, High Access

The school climate is a significant environmental factor affecting the successful use of online computer technology in schools. Schools with a positive climate are characterized as a place in which much thought is collectively given to the way adults interact with students and with each other. In contrast, negative school climates are places where in which difficult relationships among administrators, teachers and students are obstacles to be overcome.

Administration

The attitudes, ideas and leadership style of building and district administrators impact upon school climate by affecting the level and type of communication that occurs, as well as the support felt by individuals. The administrator is a significant actor in all aspects of the process of implementing online computer technology into the classroom. His/her leadership and active support of the technology plan may make a difference between a successful or unsuccessful implementation.

The role of the principal in the adaptation of teachers to the use of technology in the classroom is evident in the leadership they provide.

As you can see, the building administrators truly hold the key. If they are into it, then they push if not the building is out of luck. Lisa, Low Access

Effective administration provides a level of professional leadership that empowers their staff.

I have a very good relationship with my principal. She gives me the total freedom that I have needed to set up my program. They have always let me experiment and make mistakes without being chastised. This has given me the freedom to go that extra mile and take risks that I would not have taken if I didn't have this freedom. Rita, Low Access

Good administrators are supportive and flexible, accommodating the needs of their teachers in a number of ways.

As for the administration, I could not have a more supportive principal and so I am free to explore new approaches and share them with teachers. She is the first one to put me on a committee or suggest that we present at a conference and share what we have learned. She has allowed me the flexibility to try and succeed in many new projects. Sandy, High Access

The district administrator is a somewhat more distant presence, but one that can still exercise leadership in the school. School districts often take actions that facilitate the uniform access to online technology in their schools.

Each school has access (paid by the district) and teachers were able to apply for accounts. Part of the agreement is a willingness to share information and write Internet lesson plans. Access is from home and school. Liz, High Access

Administrators can devote the resources needed to replicate successful programs in other schools throughout the district.

I write a weekly newsletter with ideas, projects I have seen posted and new locations to visit. This year the district has hired me for half of the day to work with teachers in other schools and so they can pass out the newsletter to the rest of the staff. Sandy, High Access

They can develop and support partnerships between schools and universities or corporations that stimulate the use of online computer technology in the classroom.

School administrators at both building and district levels are significant actors in the climate of an individual school. Their leadership and active support of the use of online technology can ensure that it will be uniformly accessible to teachers and students in a school. A lack of administrative leadership and support becomes a barrier to school change that is difficult to overcome. It limits professional growth by teachers and reinforces the implicit structure of school.

Implementation

Few things foreshadow the use of online computer technology in the classroom quite so much as the process through which it was initially implemented. Implementation is a complex phenomenon that includes planning and decision-making. It encompasses not only the structural elements of wiring and equipment, but the sociocultural elements that support teacher adaptation to change. These include the efforts to help teachers feel comfortable with the new technology before the actual process of implementation begins.

> *The staff preparation began in the fall before any of the wires were in place. A team of graduate students from the University came to the school with modems and phone lines. They set up a demonstration of what we might be able to do. This was great to wet the appetite of the teachers. We got into groups and brainstormed how we might use this resource. Later as our connection was made, this team returned to in-service small groups on how to use e-mail and the gopher. One of the Doctoral students then adopted us and began to come to our campus one day a week to trouble shoot and help in any way. He has become a member of the staff and so well liked that he is welcome in any class. Teachers wait for his day to do projects, and plan activities. Sandy, High Access*

The decision to bring online computer technology into the school is often the result of a group process. Typically it involves planning by a site-based management committee or a specific study team that subsequently makes recommendations to the staff and principal. The decision may result from contact with an outside entity such as a university, a corporation, or an accreditation agency. In some cases, the decision is a personal one, by a teacher who wants to use online resources in his/her classroom and, through personal persuasion or persistence, is able to obtain the money to do so.

> *We only have one telephone line. I strung a line from the computer lab to my lab and use it in my lab. The computer lab instructor does not use it at all. We have plans for putting one line in the library next year. We are using my personal account at school and then I use it at home. Cost $25 a month. We may next year get the money from the Technology Fund. Terry, Low Access*

The role of the outside agent in the successful implementation of online computer technology in a school is very important. The equipment involved in a fully networked school is expensive and technically sophisticated. Outside agents, typically university, corporate, or governmental groups, offer financial support, donate equipment, and provide both technical and curricular support for the use of online computers in many schools.

> *Access is from home and school. We also were able to have more accounts than most schools when we became a National Testbed Site this summer. Those teachers who wanted to be part of the project and were willing to try constructivist strategies in their rooms using telecommunications became part of our initial project team. 20 teachers joined our team and all of us have PPP accounts that we do not have to pay for. Liz, High Access*

It was our partnership with Motorola which finally convinced the district to pilot the idea of one computer for each classroom teacher. Motorola has given us a server and helped by supplying technical support to the district so that our tech. people can now install the routers and hubs. Sandy, High Access

The subjects of this study most often discuss technology planning in terms of the current use of online computer technology, as opposed to considering it in terms of the initial implementation process. Successful planning efforts become part of the school culture, often stimulated by the district office or the principal.

For years, the district has had schools write their own Site Plans which led to Instructional Plans which led to Magnet Plans which led to Technology Plans.
Liz, High Access

Planning becomes an ongoing activity that focuses on ways to use technology more efficiently in a curricular setting. This may mean establishing a computer laboratory to supplement classroom access to online technology.

The teachers are most involved now in trying to get a lab that will have access as well as some computers more powerful than our LCIIs. We want to get a grant for a mini lab of 3 or to move to classrooms when special projects are in process. Sandy, High access

When planning focuses on equipment and software, the important element of professional development may be neglected.

We put computers in every classroom, but offer little or no training in their use, put aside little time for brainstorming ways to use them and seem to feel comfortable with that. Paul, Low Access

Teachers may perceive a lack of honest support by administrators for the use of online technology.

Truth be told, the administration would like their school to be online and networked, but I have changed my ideas as to why. At first I thought they wanted technology to progress in this direction because they had made an educational philosophical commitment and understood its value.. But as time has gone by, the support I expected is just not there. Even the tech committee is by and large uninterested in the process. Juanita, Low Access

The effective use of online computer technology as a vehicle for enacting the curriculum depends on the adaptation of teachers to the use of technology in the classroom. The various studies of ACOT classrooms demonstrate that teachers go through various stages as they adapt to teaching with technology. These include: entry, when new technology enters the classroom; adoption, when teachers and students first begin to use the new technology; adaptation, when teachers and students adapt to the use of technology in the classroom; appropriation, when teachers themselves master the computer and it becomes a tool for doing actual work; and invention, when teachers conceptualize new educational uses for computers in the classroom (Dwyer et al, 1990a). Teacher appropriation of classroom technology is clearly the result of the individual's capacity to change, not simply the act of placing of computer technology in the classroom.

When technology began, we were all like the kindergarten student who was either eager to learn or unable to leave mom (the manual) or was frightened of the unknown. As teachers, now could more easily relate to the frustrations students felt when new curricula was introduced, I believe there was more understanding of how students learn than before. We have gone through all the stages ourselves and have seen some of us blossom while others need more nurturing and guidance. Liz, High Access

Teacher adoption of online technology, like any successful change effort, typically takes a great deal of time. One subject estimates that it took 2.5 years of full access for the majority of teachers in her small school to become comfortable with the use of online computer technology in the classroom.

> *Change did not occur my first year in my present position-only with the students. During our first year of technology implementation, the teachers had planning time when their kids came to the lab. Big mistake-the kids started becoming literate but the staff did not. We changed that in the following years: teachers come with students and my job is to have them actively involved in the lessons or set up a situation where they explore something new. Liz, High Access*

A technology plan needs to think of teacher adaptation as well as the implementation of hardware and software. It needs to recognize that teacher adaptation is a developmental process.

> *Everyone must go through several phases before they are part of the "determined users" category. You must first become familiar with the system by starting with email. Our teachers are doing this; once they venture on to the web, they become more than a casual observer but an actual participant in web happenings. Some bring their students along on the journey; others aren't quite ready. The unknown is scary and with all the hype about what is possible non-educationally for students to encounter, some teachers are reluctant to use the resources available. I have found that by directing teachers and students to acceptable sites that both are more ready to use the resources that tie in with the curriculum. Presently 10-18 of our teachers are involved with projects beyond email. Liz, High Access*

The Office of Technology Assessment Study (U. S. Congress, Office of Technology Assessment, 1995) finds that extensive staff development is a necessary prerequisite for the successful adaptation computer technology by teachers.

> *The staff development based on technology had started everyone off at the ground floor; now those that have moved higher up the staircase definitely do help out others-what's more staff is not afraid to ask for help. They don't feel that they're not as good as someone else if they ask for help. Exchanging messages through e-mail also allows people to deal with some of the touchy issues that can't always be handled with students around. Telecommunications has given the staff more ideas on the integration of technology into their plans. Yes, technology has helped break down those classroom barriers along with allowing teachers to have more input into the day to day school activities and helping to plan together for the vision of what we think school should be all about. Liz, High Access*

Subjects working in schools in which have a high degree of access are uniformly a part of a culture in which training and professional development is the norm.

Professional development assumes many forms. Training may begin before the equipment is installed. Demonstrations, modeling of classroom use, and playing with computers are successful ways of introducing technology to teachers. Some schools allow teachers to take computers home for the summer or during holidays. Training in the high access schools is typically one-to-one. One group of schools used a 'trainer of trainers' methodology of staff development. The new trainers ultimately transfer to different schools in order to spread expertise throughout the district. At least two schools in this sample train upper level students to become computer aides in the classroom.

A majority of the participants in this study have had little or no formal training in the use of online computer technology, and have constructed the use of online computers in their classrooms on their own. Typically these educators work in schools in which the access to online computer technology is very limited. Newly trained teachers may be viewed as the technological experts and are expected to design and implement staff development sessions at their schools.

Some low access schools severely limit the amount of time teachers have for learning about technology, or adapting it to classroom use. Money for new equipment or training is difficult to find. School district leadership is not supportive, or anti-technology and has a difficult time conceptualizing change.

> *It seems that we can find money for the big ticket items, but we do a poor job training staff and fall short of funding the other stuff, i.e. software, that is needed to make the programs really work. Paul, Low Access*

Those who advocate for online technology in low access schools often have to confront teachers fears about the changes that may result from introducing it into the school.

> *It is extremely frightening to many teachers because once we are on-line, we are going to have to find a new way to teach. We are going to have to give our students some freedom and independence many don't think they can handle. Lisa, Low Access*

Any school in the process of adopting online computer technology must contend with the unchanging expectations and ideas of the school district.

> *Many curriculum demands are placed on teachers by District guides and also the need to raise test scores. Until we can get those at the District level to see what students can do and see the value of technology to increase student learning, we are facing problems. Liz, High Access*

Lack of support from the school board and the community can slow the implementation and adaptation of online computer technology for years.

> *Part of our problem is that we just got rid of several school board members that didn't even believe we needed computers. They were still arguing about whether our students should be using calculators in class. Lisa, Low Access*

The implementation process can significantly affect the rate and quality of the adaptation of the staff to the use of online computer technology in the classroom.

> *At this point, we are trying to get faculty to find ways to use the computers, either in their classrooms or in the lab, with their students. Success is limited. We just completed our presenter package, so perhaps now people will be more willing to use the computers, since everyone can see the image. Online work--that is in the future. First we need access, then we need a commitment on the part of a yet-to-be-trained faculty to use it. Advocates are a small voice, meeting not so much opposition as ennui or fear born from techno-phobia. Paul, Low Access*

The decision-making and planning processes can help build staff interest in the use of online computer technology in the schools. The presence of an outside agent such as a university, corporation or government agency can provide support and assistance. Finally the staff's adaptation to the use of online computers and their comfort with the medium, is enhanced by an ongoing culture of staff development that focuses on teachers use of online technology in a curricular context.

The Relationship of Climate to Access

The relationship of school climate to a high degree of access to online compute technology is clearly apparent. A positive school climate allows a high degree of access to develop. The aspects of a positive school climate include trust and collaboration among the professional staff, a culture of professional development, a respect for students as individual learners and administrative encouragement and support. Together, these factors help make the difficult transition to online technology easier. They also allow the

spirit of experimentation and exploration, so necessary for successful online teaching and learning, to develop.

A positive climate is clearly a function of leadership, professionalism and process. Effective school leadership provides support and encouragement for teachers and students. It offers them the space in which to try new things, and helps to engender a sense of community. That community is expressed in a sense of professionalism among the school staff. Teachers have a positive self-image of themselves as individuals and professionals. Relationships within the school and with the larger school community are supportive. The processes within the school value learning and professional development. Everyone within the school is characterized as a learner and efforts are made to see that everyone has an opportunity to learn. A school with a positive school climate is a school with an internal community, whose goal is enhanced student learning.

A high degree of access to online computer technology is certainly dependent on a positive school climate. Access after all depends on the ability of any member of the school community to have unrestricted use of online technology. Such freedom can only occur in a climate of trust. The bigger question, one that has not been answered by this study, is if a high degree of access can develop in a climate that was less positive. The answer to that question must way to a more comprehensive study of the social aspects of online computer technology in schools.

Conclusion

The analysis of data has demonstrated that a relationship exists between the use of online computer technology and changes in teaching and learning that can be characterized as constructivist. The subjects of this study clearly report a more clearly identified movement towards constructivist teaching practice if they come from high access schools than do teachers from low access schools. Four themes, Use, Teacher, Student and Impact, were used to organize the data from subject interviews that address the curricular and social issues of teaching and learning. The findings suggest that the classroom use of online technology itself changes the curricular interactions of teachers and learners, as well as the social dynamic of the classroom, leading to changes in teaching and learning that can be characterized as constructivist.

The data also address question two which is concerned with the structural and sociocultural context in which online technology is successfully used. The structural context is one part of what has come to be called here Access. The concept of Access addresses issues of the classroom availability of online technology, as well as the sociocultural aspect of limitations on its use by all members of the community. A positive school climate has been identified as the major sociocultural element that effects the successful use of online technology in school. Everyone of the high access schools that used online technology in an effective manner also had a positive school climate, while a number of the low access schools lacked a positive school climate. This suggests that social relationships in the school are as significant as the availability of online technology to the successful use of online computer technology in a constructivist manner.

FINDINGS

Two significant findings have emerged from this study: the significance of access to online technology and the importance of school climate as the context in which access is realized. Teachers with a greater degree of access to online computer technology exhibit a greater tendency towards constructivist educational practice than do those with little access to online technology. Furthermore, teachers at schools with a positive school climate, evidenced by the level of administrative, collegial and parental support, and a culture of professional growth, tend to have greater access to online technology than those whose school climate lacks these factors. Each them and the significance of the findings is presented below.

A Movement Towards Constructivist Teaching and Learning is Enhanced by Access to Online Technology

Access to online computer technology has been conceptualized as combining both physical access to machines and equipment, and regulations concerning their use. The type and amount of online computer technology and its location in the school are important, though not definitive factors affecting their use. It is only when regulatory elements are considered-- the question of who may use online technology under what circumstances-- that the concept of access becomes clear. Less important than the number of online resources in a school is how freely they are used. Some schools with a relatively large amount of online resources are low access schools because the use of the resource is restricted, while others with a single online computer per classroom possess a high degree of access if teachers and students are free to use it.

Ready access to online technology has had a discernible impact on teaching and learning. The participants in this study who work in schools with a high degree of access exhibit a greater tendency towards constructivist educational practices than those for whom access is more limited. This is apparent in their discussions of student learning, use of online technology, assessment practices, and descriptions of their teaching behavior. Teachers in high access schools generally conceptualize their students as individuals and discuss student learning as something that occurs individually. They use online technology as a means of communication, involving their students in projects that put them in contact with others. Teachers in high access schools typically use narrative assessments as opposed to number grades. Furthermore, their teaching style is based on individual work with students and supporting student efforts to learn by assuming the role of co-learner. In contrast, teachers with relatively less access tend to discuss student learning as something the class accomplished. Teachers in low access schools involve their students in commercial online projects, or key-pal relationships. These teachers speak of skill testing, grades for homework, tests and quizzes. They are concerned with classroom management and rely on their authority as teachers to direct the class towards knowledge.

The impact of online computer technology on teaching and learning is enabling educational change. Collins (1991) claims that the use of computers as tools for student work will ultimately lead to a movement towards more constructivist practice. This research found that computers in many schools are not used as tools to stimulate constructivist thought; rather, they serve as vehicles for the enactment of a curriculum based on drill and practice. The use of stand-alone computers as electronic workbooks reinforces a didactic model of education. Online compute technology, with its emphasis on CMC, changes the teaching and learning dynamic in school. It is not yet possible, however, to say what causes the change. Access to online technology and the communication it allows are only part of the cause. School climate, culture, staff relationships administrative support, parent involvement and professional development all play a role in the change process. This study cannot ascertain which comes first.

A Positive School Climate is Needed in Order for a High Degree of Access to Online Technology to be Obtained.

A positive school climate in which there is a high degree of access to online computer technology is found in each of the schools participating in this study. More significantly, respondents from schools in which access to online technology is relatively low all report problems with their school administration, colleagues and student that imply a less positive school climate. The relationship between school climate, conceptualized here as the contextual environment in which life in school occurs, and the effective use of online computer technology is supported by the data.

The importance of the various aspects of climate on the school has been studied by organizational theorists who found the significance of climate and culture in the workplace, particularly in terms of organizational change (Argyris & Schon, 1974). Studies of educational administration likewise focus on the role of culture and climate in the schools as a workplace (Bolman & Deal, 1992), and teachers as learners (Fullan, 1993; Sarason, 1991). In finding that a positive school climate is needed in order for online technology to be effectively used in the classroom, these earlier studies have been affirmed by this research

Conclusion

There are two findings of this study: that a high degree of access to online computer technology enhances constructivist teaching and learning, and that a positive school climate is needed for access to develop. These findings support and are supported by the research of others. They affirm and extend the work of Collins (1991), who focused on unconnected computers used as tools. This study expands the use of computers to include online use. The strength of online computer technology, as opposed to unconnected computers, is their ability to be a vehicle for communication (CMC). Although this ability is well known (Berge & Collins, 1995; Fowler & Wheeler, 1995; Harasim, 1990, 1993b; Harasim, et al., 1995; Hiltz, 1990, 1994; Hiltz & Turoff, 1978; Honey & Henriquez, 1993; Honey & McMillan, 1994, Riel, 1990, 1992, 1993, 1994), assessing the impact of CMC on constructivist teaching and learning using the trends identified by Collins (1991) is new. The identification of school climate as a significant aspect of the school as a workplace and learning community affirms the work of Little (1990) and Rosenholtz (1989) among others. It emphasizes the fact that online technology alone, despite its potential effectiveness as a tool of communication, will not lead to the type of access needed to create and support significant changes in teaching and learning. Schools with a high degree of access to online computer technology display a greater degree of movement towards constructivist practice, given the trends presented in Collins (1991), than do schools with a low degree of access to online technology. The degree of access depends less on the amount of technology in the school than it does on the climate in which it is enacted.

The focus of this research has been the impact of online technology on teaching and learning. In design, data collection, and method, however, the focus was on teachers and teacher practice. The questions asked of teachers shed light on their beliefs and practices that allowed inferences to be made about student learning. However data from students evaluating their experiences with online technology, and documenting measures that would assess changes in student learning attributable to online technology, were not obtained. Although it is clear that the communication enabled by online technology augments student learning it is unclear how such evaluative measures will be established aside from existing studies on student writing ability (Fowler & Wheeler, 1995; Riel, 1994).

The next steps in assessing the impact of online computer technology on student learning must involve comparative studies of classes with online technology, and those without, covering similar disciplinary content and using similar assessment techniques. This will enable a focused conclusion about the ways in which online technology augments student learning.

An additional question left open by this study is that of causality. Online interviews though a useful form gathering deep, reflective, ideas does not allow the researcher to spend time in a site and draw conclusions about the causal relationships of change. Impact cannot fully be assessed without spending a significant amount of time in a school that is in the process of implementing the use of online technology. A more ethnographic study would be able to establish the relationships among people, rather than relying on the reports of such relationships by one person.

REFERENCES

Altheide, D. L. & Johnson, J. M. (1994). Criteria for assessing interpretive validity in qualitative research. In N. K. Denzin & Y.S. Lincoln, eds. (1994). Handbook of qualitative research. Thousand Oaks, CA: Sage Publications. (485-499).

Argyris, C. & Schon, D. A.(1974). Theory in practice: Increasing professional effectiveness. San Francisco: Jossey-Bass.

Bartlett, S. F. (1932). Remembering: A study in experimental and social psychology. Cambridge, England: Cambridge University Press.

Berge, Z. L. & Collins, M. P. eds.(1995a). Computer mediated communication and the on-line classroom, volume I: Overviews and perspectives. Cresskill, NJ: Hampton Press.

Berge, Z. L. & Collins, M. P. eds.(1995b). Computer mediated communication and the on-line classroom, volume III: Distance learning. Cresskill, NJ: Hampton Press.

Bolman, L. G. & Deal, T. E. (1992). Leading and managing: Effects of context, culture and gender. Educational Administration Quarterly, 28 (3). 314-329.

Bowers, C.A. (1988). The cultural dimensions of educational computing. New York: Teachers College Press.

Brown, A. L. & Campione, J. C. (1994). Guided discovery in a community of learners. In K. McGilly, ed. Classroom lessons: Integrating cognitive theory and classroom practice. Cambridge, MA: MIT Press/Bradford Books. 229-270.

Brown, J. S., Collins, A. & Duguid, P. (1989). Situated cognition and the culture of learning. Educational Researcher, 18 (1), 32-42.

Cobb, P. (1995). Continuing the conversation: A response to Smith. Educational Researcher, 24 (7), 25-27.

Cobb, P. (1994). Where is the mind? Constructivist and sociocultural perspectives on mathematical development. Educational Researcher, 23 (7), 13-20.

Collins A. (1991). The role of computer technology in restructuring schools. Phi Delta Kappan, 73 (1), 28-36.

Collins A. (1993). Design issues for learning environments. (Report No. IR 016 092). New York: Center for Technology in Education. (Eric Document Reproduction Service No. ED 357 733)

Cuban, L. (1986). Teachers and machines: The classroom use of technology since 1920. New York: Teachers College Press.

Cuban, L. (1989). Responses to " Visions for the Use of Computers in Classroom Instruction": Neoprogressive visions and organizational realities. Harvard Educational Review, 59 (2). 217-222.

David, J. L. (1993). Teaching and learning with TENET. In J. L. David (1993) TENET after one year. (Report No. IR 016 627) Naples, FL: WEB Associates. (ERIC Document Reproduction Services No. ED 371 713), 5-14.

Duffy, T. M. & Jonassen, D. H., eds. (1992). Constructivism and the technology of instruction: A conversation. Hillsdale, NJ: Lawerence Erlbaum Associates

Dwyer, D. C., Ringstaff, C., & Sandholtz, J.H. (1990a). Teacher beliefs and practices, part I: Patterns of Change. Apple Classrooms of Tomorrow Report No. 8., Cupertino, CA: Apple Computer, Inc.

Dwyer, D. C., Ringstaff, C. & Sandholtz, J.H. (1990b). Teachers beliefs and practices, part II: Support for Change. Apple Classrooms of Tomorrow Report No. 9, Cupertino, CA: Apple Computer, Inc.

Foster, G. (1994). Fishing with the net for research data, British Journal of Educational Technology, 25 (2), 91-97.

Fowler, L. S. & Wheeler, D. D. (1995). On-line from the K-12 classroom. In Z. L. Berge & M. P. Collins, eds. (1995a). Computer mediated communication and the on-line classroom, volume I: Overviews and perspectives. Cresskill, NJ: Hampton Press. (83-100)

Fullan, M. (1993). Change forces: Probing the depths of educational reform. London: The Falmer Press.

Gearhart, M., Herman, J. L., Baker, E. L.; & Novak, J. L. (1990). A new mirror for the classroom: The effects of technology in instruction. Paper presented at the Annual Meeting of the American Educational Research Association, Boston.

Glaser, B. G. & Strauss, A. L. (1967). The discovery of grounded theory: Strategies for qualitative research. Chicago: Adeline Publishing Co.

Gunawardena, C. N. (1992). Changing faculty roles for audiographics and online teaching. The American Journal of Distance Education, 6 (3). 58-71.

Harasim, L. M., Ed. (1990). Online education: Perspectives on a new environment. New York: Praeger.

Harasim, L. M., Ed. (1993a). Global networks: Computers and international communication. Cambridge, MA: MIT Press.

Harasim, L. M. (1993b). Networlds: Networks as social spaces. In L. M. Harasim, Ed. (1993), Global networks: Computers and international communication (15-34). Cambridge, MA: MIT Press.

Harasim, L. M., Hiltz, S. R., Teles, L. & Turoff, M. (1995). Learning networks. Cambridge, MA: MIT Press.

Harrington, H. (1992). Fostering critical reflection through technology: Preparing prospective teachers for a changing society. Journal of Information Technology for Teacher Education, 1 (1). 67-82.

Heaviside, S., Farris, E., Malitz, G. & Carpenter, J. (1996). Advanced Telecommunications in U. S. public elementary and secondary schools, 1995. Washington, D.C.: National Center for Educational Statistics, Office of Educational Research and Improvement,
U. S. Department of Education.

Hiltz, S. R. (1990). Evaluating the virtual classroom. In L. M. Harasim, Ed. (1990). Online education: Perspectives on a new environment (134-183). Cambridge, MA: MIT Press.

Hiltz, S. R. (1994). The virtual classroom: Learning without limits via computer networks. Norwood, NJ: Abelex.

Hiltz, S. R. & Turoff, M. (1978). The network nation: Human communication via computer. Reading, MA: Addison Wesley Publishing, Inc.

Honey, M. & Henriquez, A. (1993) Telecommunications and k-12 educators: Findings of a national survey. (Report No. IR 016 132). New York: Center for Technology in Education. (ERIC Document Reproduction Service No. ED 359 923)

Honey, M. & McMillan, K. (1994). Case studies of k-12 educators' use of the internet: Exploring the relationship between metaphor and practice. Machine Mediated Learning, 4 (2 & 3). 115-128.

Iran-Nejad, A. (1994). The global coherence context in educational practice: A comparison of piecemeal and whole-theme approaches to learning and teaching. Research in the Schools 1, 63-76.

Iran-Nejad, A. (1980). The schema: A structural or a functional pattern (Tech. Rep. No. 159). Urbana: University of Illinois, Center for the Study of Reading. (ERIC Document Service No. ED 182 735)

James, M. L., Wotring, C. E. & Forrest, E. J. (1993). An exploratory study of the perceived benefits of electronic bulletin board use and their impact on communication behavior. (Report No. IR 016 078). Las Vegas, NV: Broadcast Education Association. (ERIC Document Reproduction Service No. ED 360 950)

Jonassen, D. (1992). Evaluating constructivist learning. in T. M. Duffy & D. H. Jonassen, eds. (1992) Constructivism and the technology of instruction: A conversation. Hillsdale, NJ: Lawerence Erlbaum Associates (137-148)

LeCompte, M. D., Preissle, J and Tesch, R. (1995). Ethnography and qualitative design in educational research. San Diego, CA: Academic Press.

Little, J. W. (1990). Teachers as Colleagues. in A. Lieberman, ed. (1990). Schools as Collaborative Cultures: Creating the future now. New York: The Falmer Press. 165-194.

Little, J. W. (1993). Teachers' professional development in a climate of educational reform. Educational Evaluation and Policy Analysis, 15 (2). 129-151.

Marsh, G. E. & Iran-Nejad, A. (1994). Constructivism and the reform of education. Unpublished manuscript.

Piaget, J. & Inhelder, B. (1970). The psychology of the child. New York: Basic Books.

Richardson, V. (1994). Constructivist teaching: Theory and practice. Paper presented at the annual meeting of the American Educational Research Association, New Orleans.

Riel, M. (1990). Cooperative learning across classrooms in electronic Learning Circles. Instructional Science, 19, 445-466.

Riel, M. (1992). Making connections from urban schools., Education and Urban Society, 24 (4) 477-488.

Riel, M. (1993). Global education through Learning Circles. In L. M. Harasim, Ed. (1993). Global networks: Computers and International Communication (221-236). Cambridge, MA: MIT Press.

Riel, M. (1994). Educational change in a technology-rich environment. Journal of Research on Computing in Education, 26 (4). 452-474.

Ringstaff, C., Sandholtz, J.H. & Dwyer, D. C. (1991). Trading places: When teachers utilize student expertise in technology-intensive classrooms. Apple Classrooms of Tomorrow Report No. 15, Cupertino, CA: Apple Computers, Inc.

Rosenholtz, S.J. (1989). Teachers Workplace: The social organization of schools. New York: Longman.

Sarason, S. (1991). The predictable failure of educational reform. San Francisco: Jossey-Bass.

Schifter, D & Simon, M. A. (1992). Assessing teachers' development of a constructivist view of mathematics learning. Teaching and Teacher Education, 8, 187-197.

Schofield, J. W. (1995). Computers and classroom culture. New York: Cambridge University Press.

Schrum, L. (1992). Professional development in the information age: An on-line experience. Educational Technology, 32 (12). 49-53.

Sudamlis, L. (1992). The electronic survey as a research tool: A case study of BALT-L. (Report No. IR 054 530). Masters Research Project. Kent, OH: Kent State University. (ERIC Document Reproduction Services No. ED 355 969)

Teles, L. (1993). Cognitive apprenticeships on global networks. In L. M. Harasim, Ed. (1993) Global networks: Computers and International Communication (271-282). Cambridge, MA: MIT Press.

U.S. Congress, Office of Technology Assessment (1995). Teachers and technology: Making the connection. Washington, D. C.: U. S. Congress, Office of Technology Assessment.

Vygotsky, L. S. (1978). Mind in society: The development of higher psychological processes. Cambridge, MA: Harvard University Press.

Wilson, B. G., Hamilton, R., Teslow, J. L. & Cyr, T. (1993). Evaluating the impact of technology at Peakview Elementary School. (Report No. IR 016 370) New Orleans: Proceedings of Selected Research and Development presentations at the Convention of the Association for Educational Communications and Technology. (ERIC Document Reproduction Service No. ED 362 214)

Wilson, B. G., Hamilton, R., Teslow, J. L. & Cyr, T. (1995). Technology making a difference: The Peakview Elementary School study. Syracuse, N.Y.: ERIC Clearing House on Information and Technology.

Winn, T. & Coleman, I. (1989). Responses to "Visions for the use of computers in classroom instruction": Urban and rural: A dialogue about computers in schools. Harvard Educational Review, 59 (2) 212-217.

APPENDIX 1

Interview Question Format

Interviews will be conducted online, via email exchanges between researcher and subjects. It will be designed to address the research questions:

1, Are teachers who use online computer technology in their classroom in technology rich schools more likely to exhibit the practices of a constructivist teacher identified by Collins (1991), than those who are isolated users of computer technology in their classrooms?

2, Which structural or sociocultural elements of school support the use of online computer technology in a constructivist manner?

The interviews will be unstructured, allowing for more contextual richness in the answers. The path of questions outlined below is better characterized as a topical guide than an actual interview protocol. Together they represent a direction to be followed during the course of the interview, allowing for digressions based upon responses of the subjects.

1, Larry Cuban (1995) has characterized the use of online computer technology in the schools as a "small cadre of determined users among a large majority of casual or non-users". Does this accurately describe the situation at your school, or would you characterize your school differently?

2, Were you working at the school when the decision to invest in online computer resources was made? If so, how was the decision made? Who was involved in the decision making from the school, from the district? Was there an outside entity involved? If so, who, what and what role did they play?

3, How were you trained to use online computer resources? Was it part of a school or district-wide training? If so, describe the outlines of the training? What access to online computers did you have while you were learning? What sort of technical support did you have? Do you still have technical support? Who provides it and what does it involve?

4, How wide-spread is the use of online computer resources in your school? Where are the computers located, in the classrooms, in a laboratory, in the library, in the administrative offices? If there is laboratory, how is it used? If there are computers in the library, how are they used? What percentage of the computers in school are online?

5, Who has direct access to online computers? Do you have access, is it unlimited? Do your students have access? What kind of restrictions are placed on student access? What are the concerns are the basis for these restrictions?

6, Lets discuss what your classroom is like. Please describe a typical session with your students. How are your students arranged? Are they in a whole group, or smaller groups? How are you interacting with them? Are you involved in direct instruction, lecturing, discussion, coaching, working with small groups, working with individuals? What are your students doing? What do you expect them to accomplish? How will you assess their work?

7, Using the model of the previous question as a basis, please describe a very good session with your students. How are they arranged? What are they doing? How are you interacting with them? What do you expect them to accomplish? How will you assess their work? Why is this class a good one for you?

8, Now let's talk about what you perceive of as a poor classroom experience. How are your students arranged? What are they doing? How are you interacting with them? What do you expect them to accomplish? How will you assess their work? Why is this class a poor one for you?

9, How would you characterize yourself as a teacher? How would you characterize your students? In what way do you see your relationship to them as their teacher? How does that manifest itself in terms of your practice?

10, Let's talk about the information available to your students on the network, how would you compare it to materials available in other media such as books, films, tapes: How would you describe your curricular use of the network: How is the information taken from the network used by students, by yourself: Describe some of the products that result from work that is done on the network: Contrast with other work the students do.

11, What role do the school and district administration play in the use of online computer technology in your school? Are they supportive of its use? In what way? Do they deter it? How so?

12, Do your colleagues use online technology? Do they use it with their students? Do they support the use of it in the school? How do they do so? Do they act to deter it? In what way?

13, What is the role of parents in your school culture? Do they have an active relationship with you as the teacher of their children? What do parents have to say about they use of online technology in your classroom, in the school? Are they supportive of it? In what way? Do they seek to limit or deter it's use? How so?

14, What do you see as the future of education when you consider the impact of online technology? What sort of impact will it have on teaching and learning? What will be the role of a teacher? What will the life of a student involve? How will these represent a change from what exists today?

15, Finally, in your mind, what is the most outstanding benefit of having online technology available in your school and what is the most serious drawback of using it in school?

APPENDIX 2

DEVELOPING A SAMPLE

This is a reproduction of an email message posted on various educational listserv discussion groups in March and September, 1995. The groups contacted included Edtech, Ednet, Kidsphere, ECIS, OASIS, ISED-L and K12ADMIN. The text of the letter is below.

"I'm in the process of designing a study of schools that are connected to online resources. I'm particularly interested in schools that use online technologies in an educational context, embedded in the curriculum, as opposed to having computers isolated and taught as a separate subject. If you think your school might be able to make a contribution, or if you'd like more information, please contact me. Thanks."

David Heflich
Area of Professional Studies
University of Alabama
dheflich@bamaed.ua.edu
dheflich@dbtech.net

Table 1 Didactic and Constructivist Educational Practices presented by Collins (1991)

Didactic Educational Practices	Constructivist Educational Practices
Predominantly whole class instruction	Predominantly small group instruction
Predominantly lecture presentations	Predominantly coaching students
Working predominantly with the better students	Working predominantly with the weaker students
Students who are predominantly less engaged	Students who are predominantly more engaged
Assessment that is predominantly based on tests	Assessment that is predominantly based on products, process and effort
A social structure that is predominantly competitive	A social structure that is predominantly cooperative
Students predominantly learning the same thing at the same time	Students predominantly learning different things at the same time
Primacy of verbal student thinking	Integration of verbal and visual thinking

Table 2: Themes, their definitions, codes and research questions to which they relate

Theme	Definition	Codes	Research Question
Access	The free, unrestricted, independent use of online resources by teachers and students in classroom situations	Access, availability, limits, location, restrictions,	Constructivist teaching Structural or sociocultural context
Administration	The actions and attitudes of those at the school and district level charged with supervising, supporting and providing leadership in schools	Administration, principal , school board, supervision, support	Structural or sociocultural context
Climate	Refers to the way things are done in school or classroom.	Attitude, climate, collaboration, communication, community, culture, involvement, parents, social structure and support.	Constructivist teaching Structural or sociocultural context
Context	Demographic and policy information	Context, job, socioeconomic status of the student body, the location of the school, the type of school, and the role of state policies	Structural or sociocultural context
Impact	The effect that the use of online technology has upon teaching and learning, including both negative and positive aspects.	Benefit, concern, danger, problem	Constructivist teaching Structural or sociocultural context
Implementation	Characterizations of the actors, decisions and policies involved in initiating the use of online technology in the school	Adaptation, barriers to adaptation, change, comfort, decision making, dependence, funding, planning, resistance, time, and training	Structural or sociocultural context
Student	Teachers thoughts, ideas, beliefs and attitudes about students and student learning.	Decomposing, engagement, empower, learning, outcome, reflection, student directed learning, visual, verbal and writing	Constructivist teaching
Teacher	Teachers attitudes, beliefs and ideas about instruction.	Assessment, authority, beliefs, coaching, constructivist, control, didactic, direct, groups, image, objective, power, project, student centered, teacher centered, thematic, teaching style	Constructivist teaching
Use	The ways in which teachers and students employed online technology in the classroom.	Communication, curricular, information, integrated, online, publishing, research	Constructivist teaching

Note: Constructivist teaching refers to Research Question One, Structural or sociocultural

Table 3. The aliases, level of school, school type, locale and degree of access of the sample

Alias	Level of School	Type of School	Locale	Degree of Access
Lani	Elementary	Public	Urban, South East	Low
Joy	Elementary	Public	Rural, West Coast	Low
Anna	Elementary	Pubiic	Rural, Mid West	Low
Sam	Elementary	Public	Rural, West Coast	Low
Liz	Elementary	Public	Urban, Mid West	High
Sandy	Elementary	Public	Urban, South West	High
Andrew	Elementary	Public	Urban, North West	High
Sunny	Elementary	Public	Urban, Hawaii	High
Max	Elementary	Private	International	High
Toni	Middle	Public	Rural, Mid West	Low
Rita	Middle	Public	Rural, North East	Low
Terry	Middle	Public	Rural, South East	Low
Paul	Middle	Private	Urban, Mid West	Low
Juanita	Middle	Private	Urban, North East	Low
Deb	Middle	Private	Urban, Mid Atlantic	High
Carol	Middle	Private	Urban, Mid Atlantic	High
Lisa	High School	Public	Urban, North West	Low
Rick	High School	Private	International	Low
Thad	High School	Public	Urban, Mid West	Low
Phyllis	High School	Public	Urban, Mid Atlantic	Low
Ralph	High School	Private	International	High
Lilly	High School	Private	Urban, West Coast	High
Miriam	High School	Private	Rural, Mid Atlantic	High
Tip	High School	Private	Urban, North East	High
Elsie	High School	Public	Urban, Hawaii	High

Table 4. Differences between high and low access schools

High Access Schools	Low Access Schools
Classrooms are connected through a LAN which provides internal and external online access	Online computers are located outside the classroom, unconnected by a LAN, or exist as a single online computer for the whole school.
The use of the online network is the unmediated decision of the teacher.	The teacher needs to schedule the use of the online computer with others.
Students are relatively free to use online resources.	Students' use of online resources is restricted.
Classes are easily able to incorporate online work into their daily curriculum.	The location in which the online computer is located has limited space for student work.
Adequate funding exists for both technology and technology training for school staff.	Funding is available for technology alone.
Leadership exists that encourages and supports the use of online technology in the curriculum	School leadership is unconcerned with the use of technology in the school curriculum
A culture of professional development exists that is devoted to increasing teachers comfort with the use of online technology.	Professional development is sporadic and available only when the individual arranges and pays for it.
Technical and curricular support exist for teachers using online computer technology.	Sporadic technical support is available.